

Investigating Motor Control

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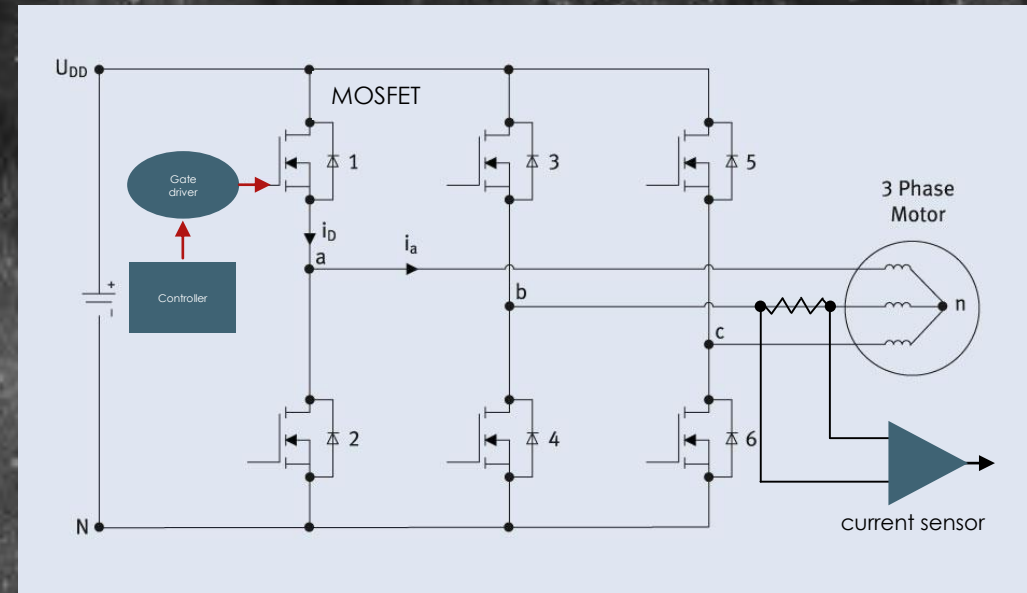
Why motor control?

- ▶ Industrial and commercial applications
 - ▶ Machinery and infrastructure
- ▶ Electric vehicles
- ▶ Heist – Hybrid electric integrated system test-bed
 - ▶ Need for custom motor controller

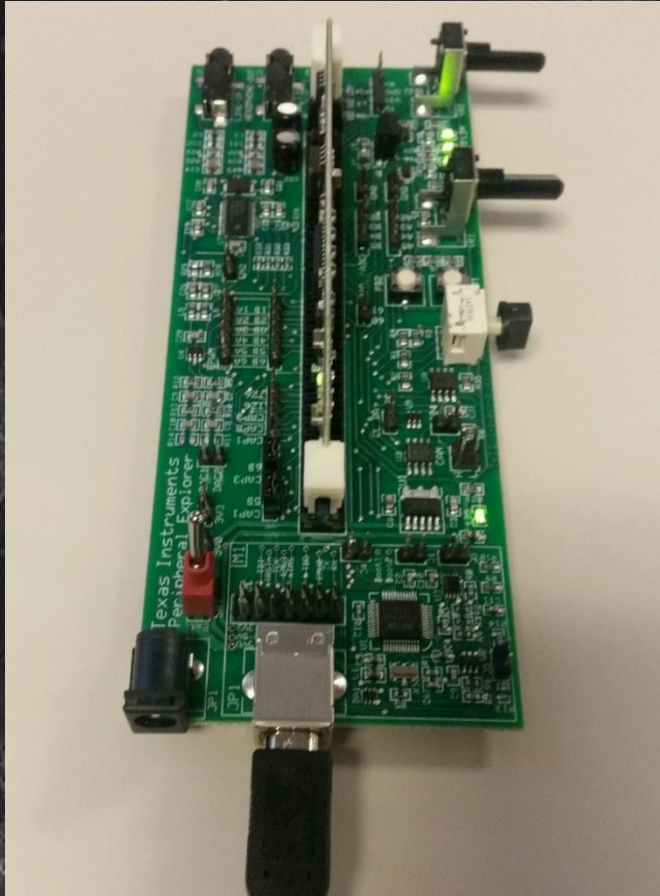


Overview of motor control system

- ▶ H-bridge
- ▶ 3 phase inductor motor
- ▶ Microcontroller
- ▶ Gate driver
- ▶ MOSFETs / Transistors
- ▶ Sine wave output
- ▶ Current sensing for feedback and PID

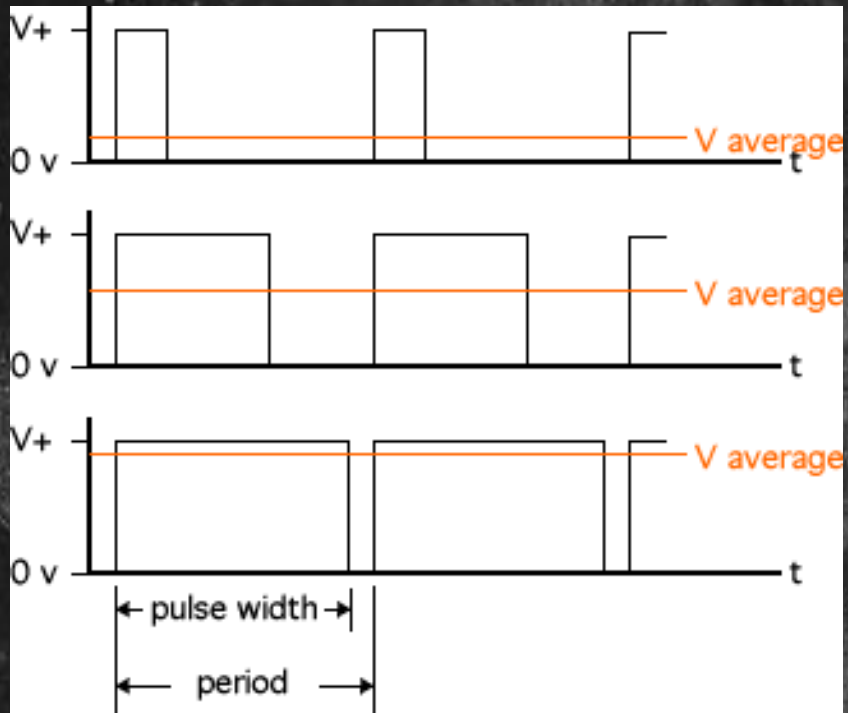


Microcontroller (F28335)



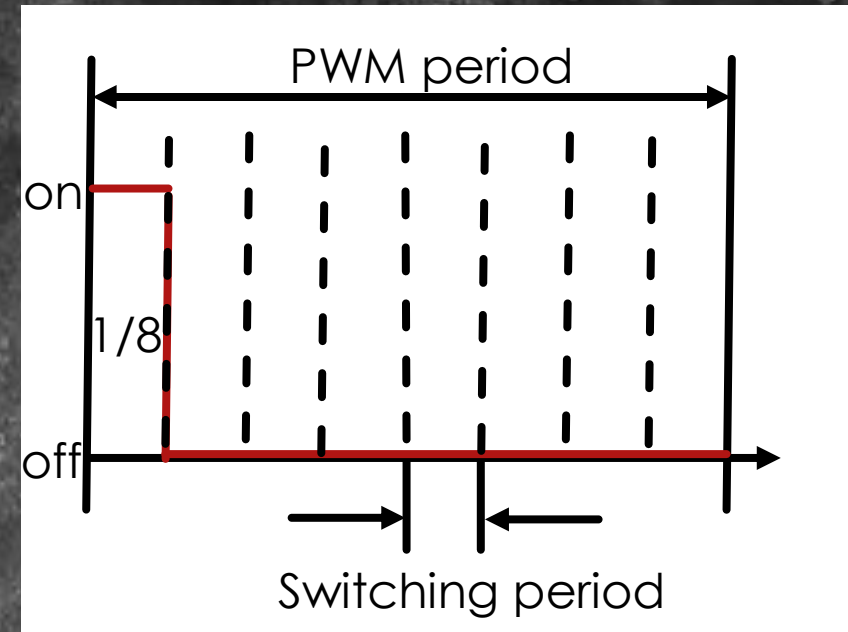
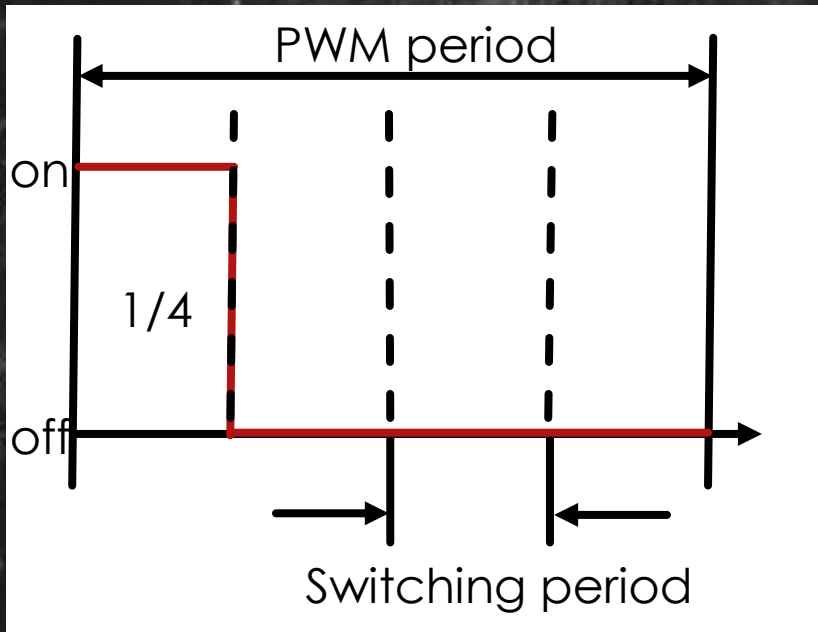
- ▶ F28335
 - ▶ CPU
 - ▶ Math units
 - ▶ Memory
 - ▶ Analogue to digital converter (ADC) and DAC
 - ▶ Timer and counters
 - ▶ Digital input and output
 - ▶ Pulse width modulation (PWM) -IMPORTANT-
- ▶ Texas Instruments explorer board

What is PWM?



- ▶ Method of approximating an analogue signal on a digital output
- ▶ Features
 - ▶ Period
 - ▶ Duty cycle / pulse width
 - ▶ Switching frequency

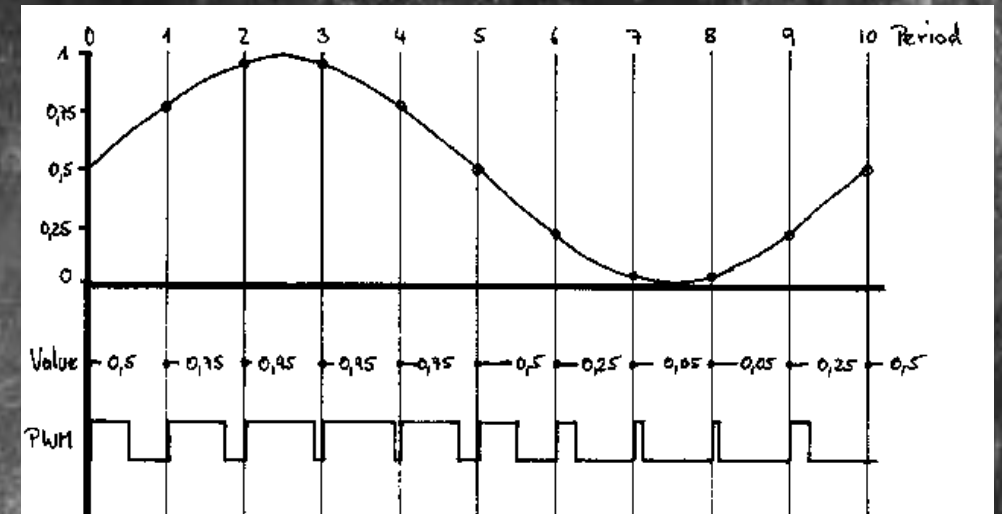
PWM resolution comparison



- ▶ Faster switching frequency = more steps in the PWM period
- ▶ More steps in the PWM period = smaller voltage step size

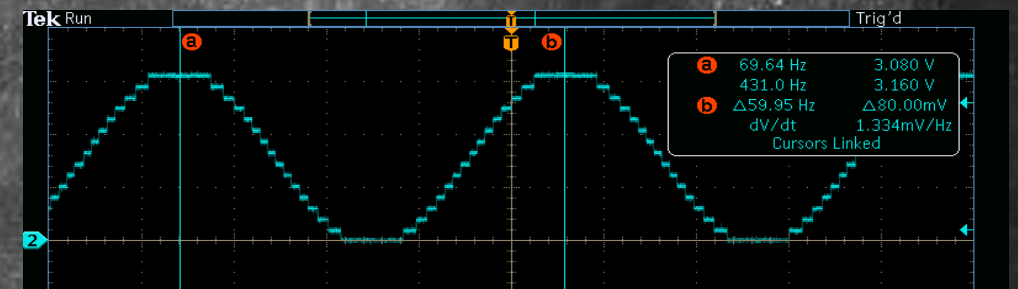
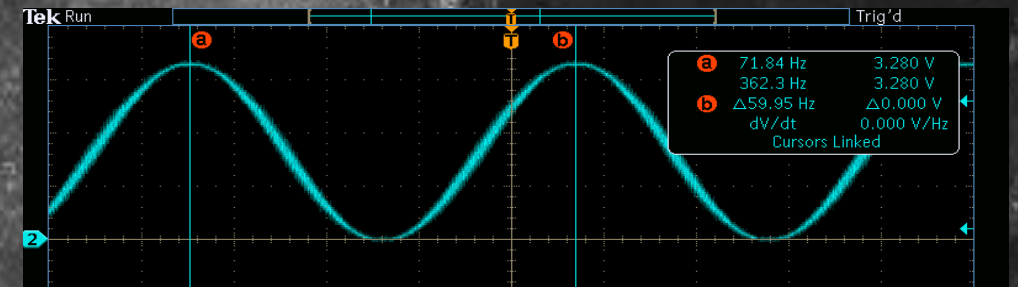
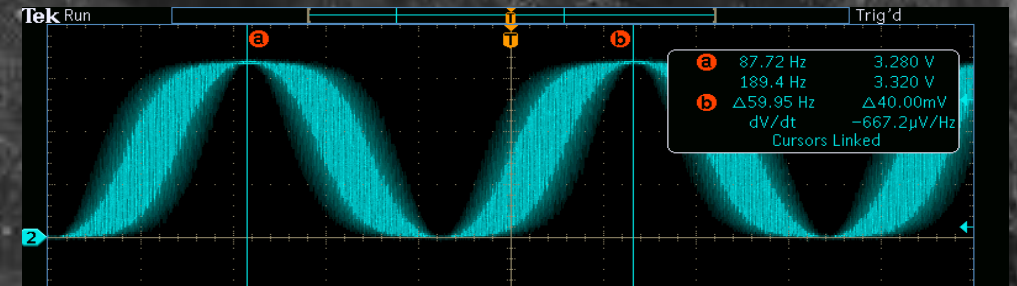
PWM sine wave

- ▶ Method for controlling motors
- ▶ On-the-fly changes to duty cycle
- ▶ F28335 has sine wave lookup table



Success – Sine wave output

- ▶ Ready to try controlling MOSFETs
- ▶ Found correct resolution

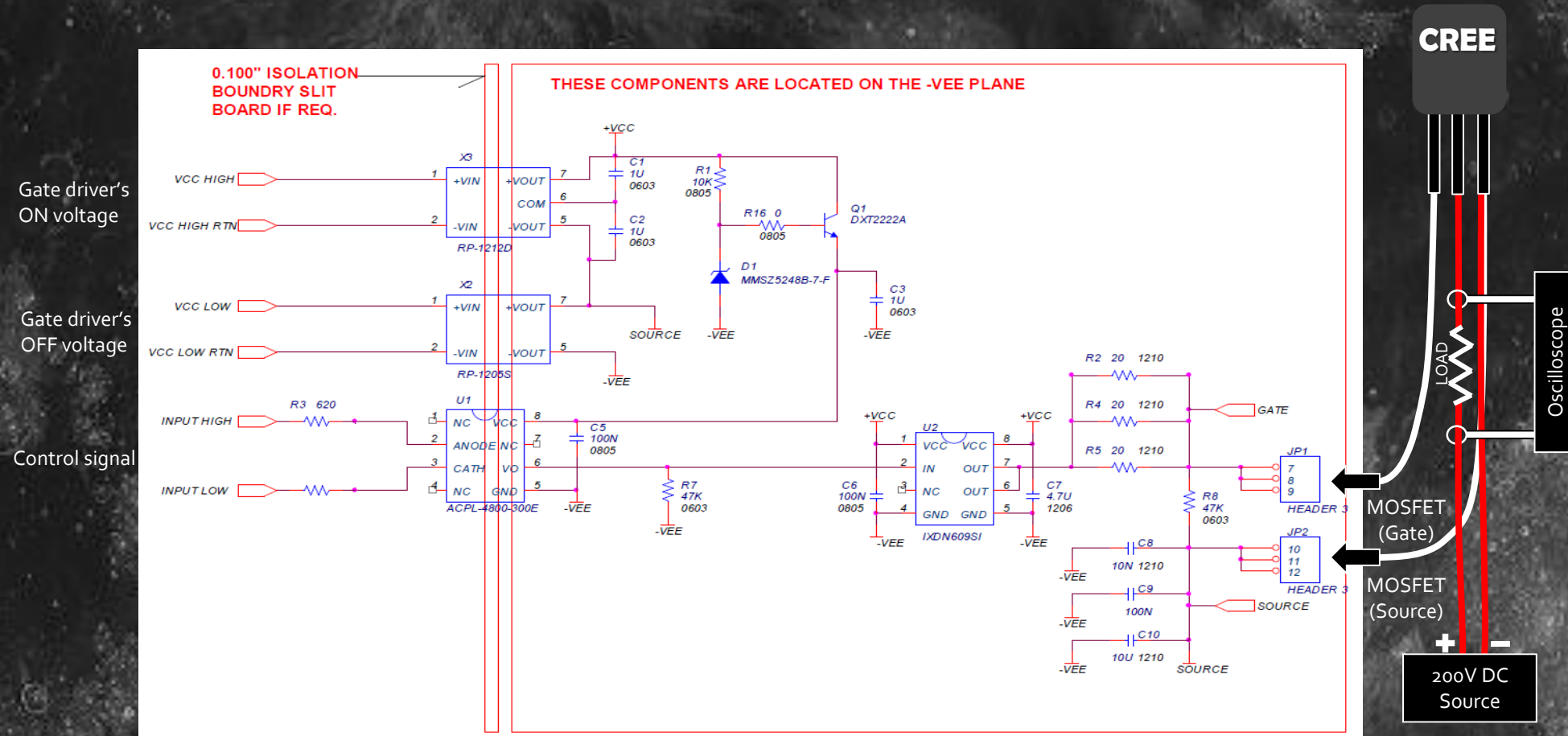


Gate driver

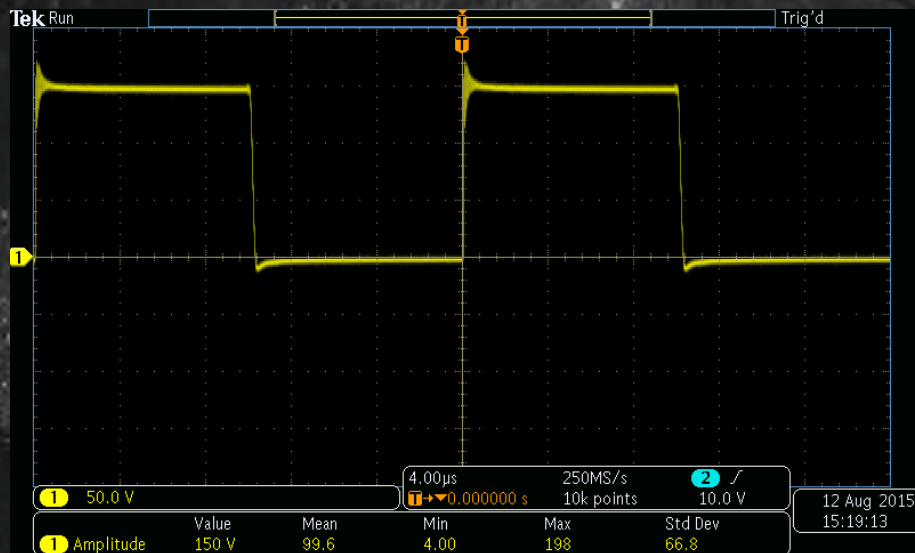


- ▶ Gate driver is like an amplifier
- ▶ Needed to control MOSFET
- ▶ Controlling CREE silicon-carbide MOSFETs
 - ▶ Faster switching
 - ▶ Better thermal conductor
 - ▶ High voltages

Experimental setup

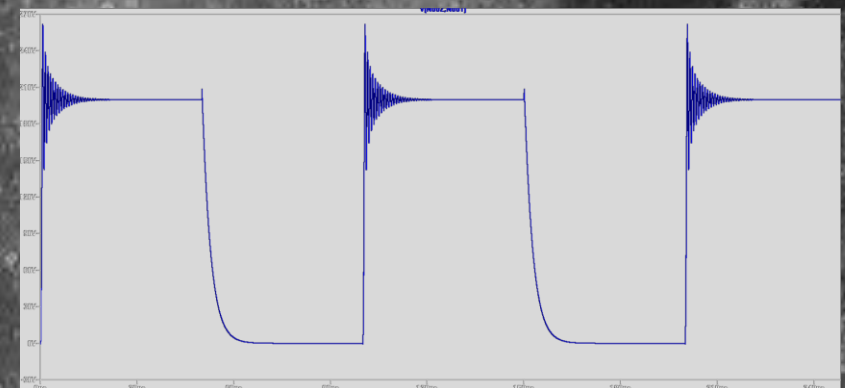
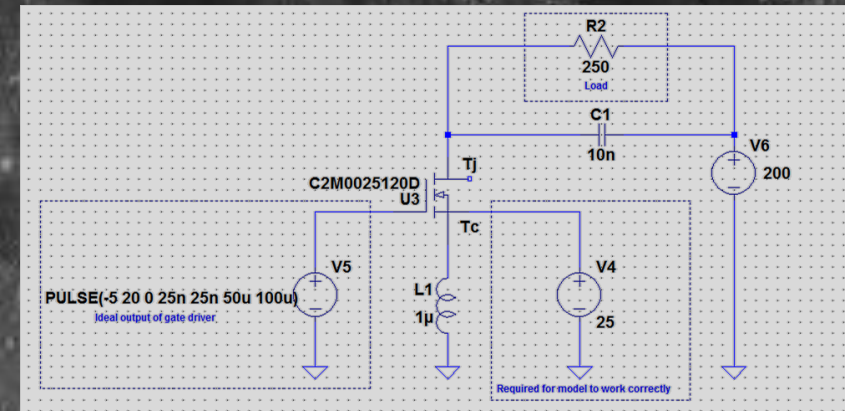
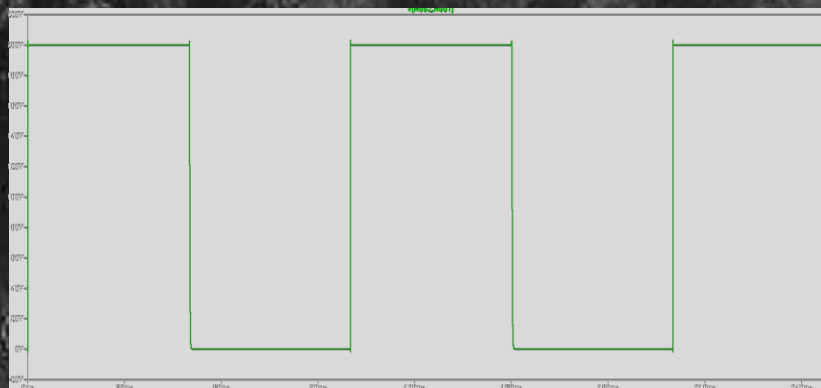
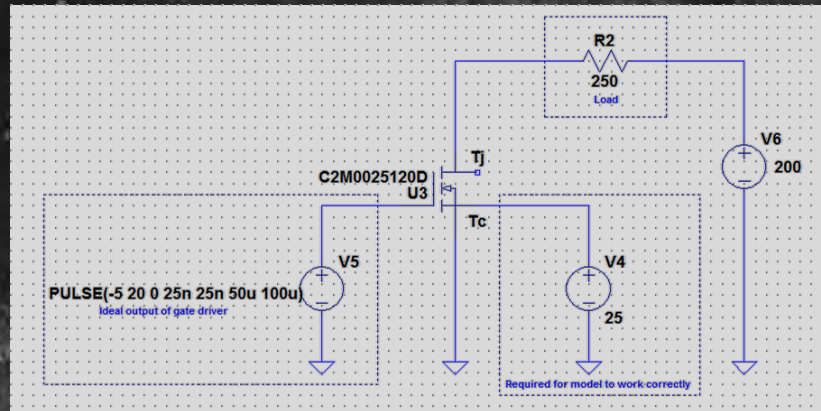


Experimental Results



- ▶ Successfully controlled MOSFET
- ▶ Switched 150V DC using 5V signal
- ▶ Not perfect output
 - ▶ Ringing

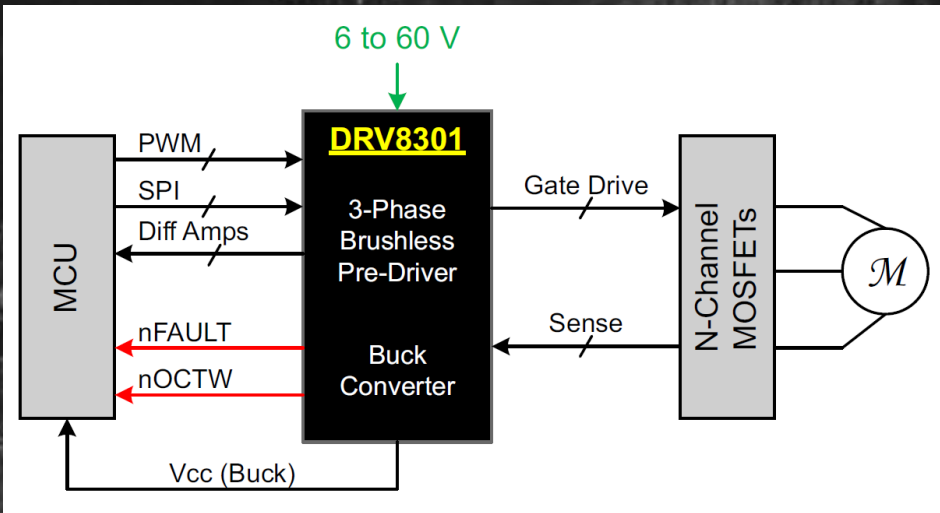
SPICE simulation results



Summery of gate driver experiment

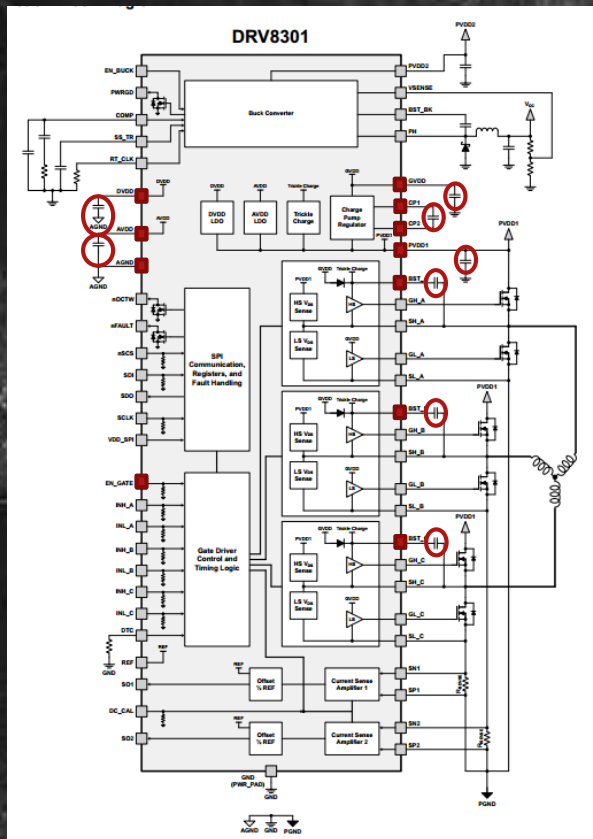
- ▶ SPICE output close, but not close enough
 - ▶ Need to make more accurate model representation
 - ▶ Use model to reduce parasitic components in gate driver output

Future work - DRV8301

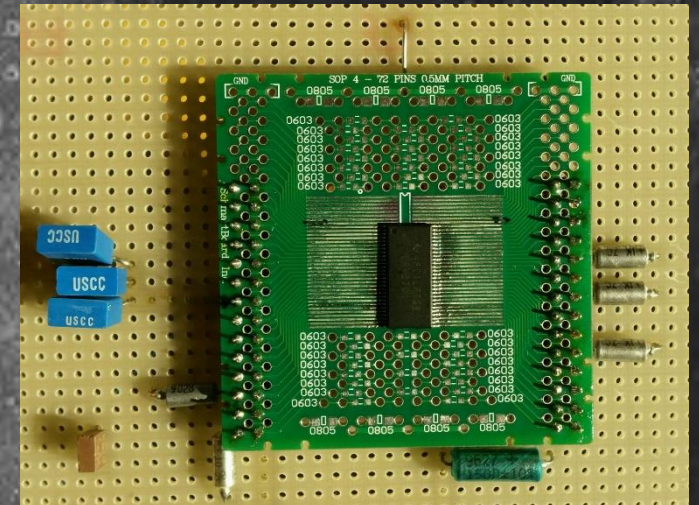


- ▶ Three-phase gate driver IC
- ▶ Hand-shaking to prevent current shoot-through
- ▶ Current shunt amplifiers for low-side current measurement
- ▶ Already have code that works with the chip

Already on my way!



- ▶ Started by connecting bare minimum
 - ▶ Power
 - ▶ Filter capacitors
 - ▶ Charge pump capacitors
 - ▶ Boot strap capacitors
- ▶ Testing was inconclusive
- ▶ Continue work



Acknowledgment

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Questions?

